

# osvrti i mišljenja



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## Ant Country<sup>1</sup>

### INTRODUCTION

I stepped into Ant Country without realizing it, way back in 1962, when I took a job at what was then called the Rade Končar Electrotechnical Institute (today called the Končar Electrical Engineering Institute), in the Sector for Automatic Regulation and Nuclear Equipment (ARNO Sector), Department for Mercury Arc Rectifiers. In the Department for Mercury Arc Rectifiers, they were developing mercury valves and rectifiers with mercury valves.

### 1. WHERE IS THE ANT COUNTRY?

I had just returned from the army (1965), and Institute Director, Professor Zlatko Plenković had just unilaterally cut salaries by 20% (I was none to blame). The reason was that the small rolling mill in the Ravne Ironworks in Slovenia was not put into operation on schedule. One of the main problems was the insufficient driving electrical impulse on the control grids of the mercury valves. For the designer of the electromotor drive of the rolling mill, it was the least important that the electrical impulse was too weak; the physical processes within the mercury valve are not at all interesting to the designers of the electromotor drive. However, for the designer of the mercury valve, this was indeed a very important process of ionization and establishing an electric arc (initiating the arc) in the valve, and their impacts on the amplitude of the electrical impulse. The system designer thus overpowers the component designer: the system designer knows what is wrong in the component design, while the component designer needs not know (and most do not know) what is wrong with the system design. The exponent in the Maxwell-Boltzmann distribution of particle speeds in gas has no influence in the system design; it can be 3 instead of 3/2 and nothing is changed in the system design. Component designers are ants and they rarely receive professional or social recognition for their work. They work in the Ant Country.

A look at the authors of papers published in American technical journals also proves the existence of Ant Country. For example, the most recent issue of the journal *IEEE Transactions on Power Electronics* (Vol. 22, No.5, Sept. 2007) contains 52 articles by 148 authors on 508 pages. Of these authors, only nine have B.Sc. qualifications in the US. Ants work in the field of designing power converters, the use of converters in electromotor drives and renewable energy sources, electromagnetic system compatibility with power converters and the like. Managers of research and development, with the help of production, multiply capital.

### 2. WHAT IS THE ANT COUNTRY?

A hierarchical diagram of the area of power electronics shows that the Ant Country is made up of converter components. The converter circuits are near to the Ant Country, while electronic power converters are far and power electronic systems are very far from the Ant Country. In order to design a system of power electronics (such as an electromotor drive), it is necessary to have the proper qualitative knowledge of converter circuits and its transfer function, while details such as the topology of the electronic switches in the converter circuit and the characteristics of the electronic valves are not at all of interest. Looking from the level of control, the converter circuit is fungible (i.e. replaceable); if it were not, it would not be possible to design the controller without knowing how to design the converter.

A hierarchical diagram of the area of power electronics in Fig. 1 shows that all knowledge from the lower levels does not need to be transferred to the higher levels (i.e. from the component level to the system level) in order to understand the phenomenon at higher levels. The levels are intellectual stopovers in the logical reduction chain from complex to simpler by separating the parts. Richard Dawkins (1941 – ; British ethologist and evolutionary theorist) states that it is not necessary to follow a phenomenon to each level of the logical reduction chain in order to understand it. For example, quantum mechanics can experience a new paradigm in its meaning given by Thomas Kuhn (1922 – 1996; American philosopher and physicist)

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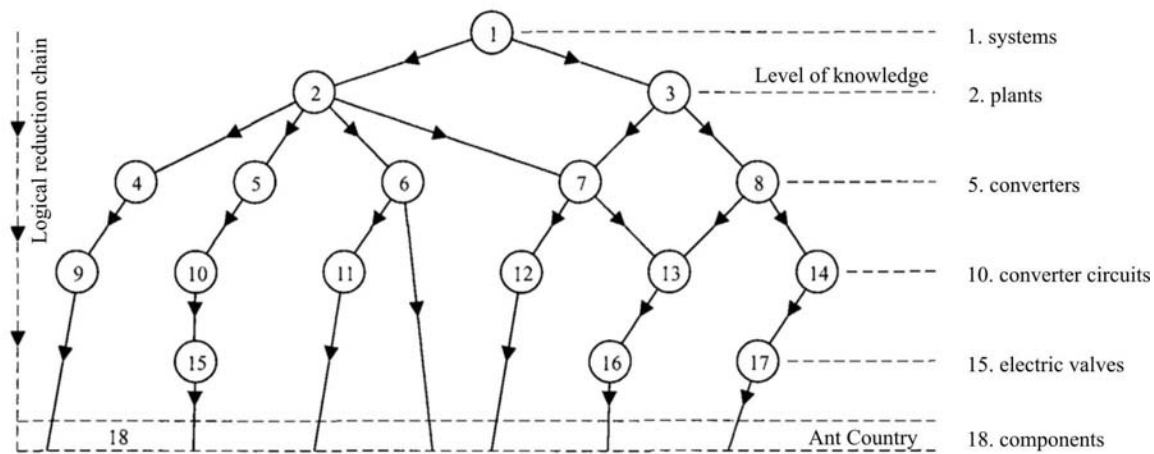


Figure 1. Hierarchical diagram of the area of power electronics

in his book *The Structure of Scientific Revolutions*, and that this cognition has no effect on the characteristics of the semiconductors components and converter circuits.

### 3. IT IS NOT NECESSARY TO KNOW THE ANT COUNTRY IN ORDER TO UNDERSTAND THE SYSTEM

Our mind does not work by starting from the details. It has developed a completely different approach to the world. Ian Stewart (1945 – ; British university professor of mathematics), in his book *Does God Play Dice?* wrote, “You know exactly what we mean when we recommend that you don’t let a goat loose in your rose-garden. . . . And it doesn’t take a deep grasp of higher mathematics to keep the goat out of your garden – just a strong fence. The detailed analysis for that fence is far beyond the reach of any equations for the structure of materials, but most of us can build a goat-proof fence. Similarly, the goat does not need to be versed in the equations of nonlinear elasticity to discover that the fence is weaker than its builders might have thought.”

Starting from higher levels (systems) and move down towards lower levels (components), the quantity of knowledge grows. In reducing the complex to its parts, we are caught in a reductionist's nightmare (e.g. there are more than 50 types of power semiconductor valves, each of four fundamental converter characteristics can be achieved with a massive number of variations of the power converter circuits). As we move down the levels of the logical reduction chain, there appears such a quantity of information that the information can no longer be organized. Much of this data surpasses what any one individual can accept and adopt in

a lifetime. Doesn't this make you panic?

The solution is in building theories that allow for the better comprehension of phenomena at higher levels, without referencing knowledge at the lower levels. In other words, understanding phenomena at higher levels must be independent of knowledge at lower levels. The confusing masses must be brought down into a comprehensible form.

#### 4. ANT COUNTRY AND THE BOLOGNA *PACTA CONVENTA*

When I took on employment at the Rade Končar Electrotechnical Institute, I was not aware of the existence of Ant Country. At the Faculty of Electrical Engineering at the University of Zagreb, we learned fundamental knowledge in electrical engineering, and knowledge about device and plant components. We learned virtually nothing about systems (the scope of knowledge on systems was contained within a single semester course based on the book *Fundamentals of Automated Regulation* by Otto Schäfer).

The newer generations are deeply aware of the existence of Ant Country and do not want to work in it. That is why they seek, in addition to technical knowledge, knowledge of economics and management. Necessarily, Ant Country will be filled by foreigners. Were someone to ask me today if I would repeat my professional life, I would respond, "No. There are different opportunities available today".

A holistic approach is desirable in undergraduate study. Old professors have a hard time accepting the fact that there is less and less room for component subjects in undergraduate study, i.e. for courses on transformers, rotational machines and semiconductor devices. These courses

belong in postgraduate study, and most appropriately in postgraduate specialist study.

## CONCLUSIONS

He who organizes research and development is the one with the power. He who manages the processes in the system has enormous power.

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